DATA CENTER ENERGY CHARACTERIZATION STUDY SITE REPORT

DATA CENTER FACILITY 1

FEBRUARY 2001

I. Review of Site Characteristics

Facility

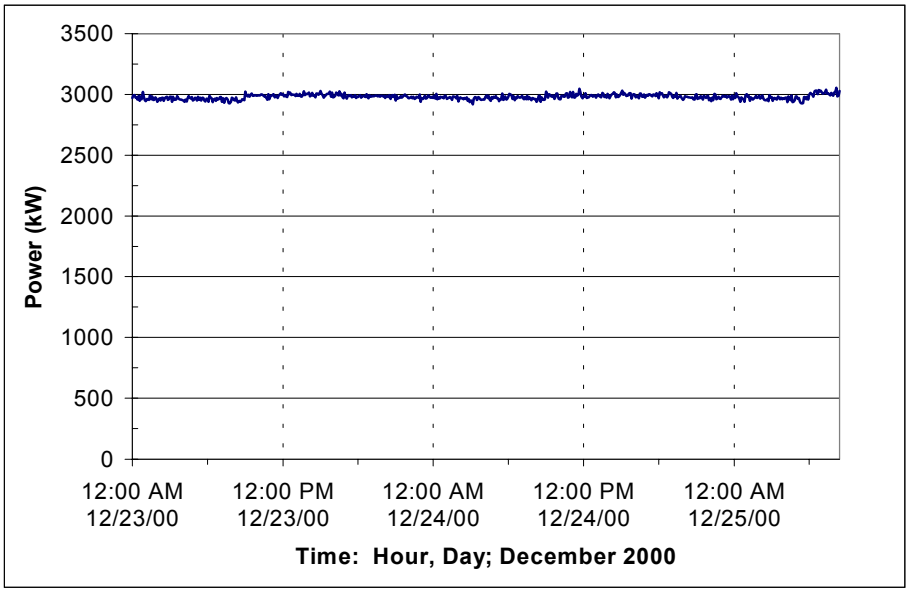
Facility 1 is a 102,500 square foot (sf) data center facility located in Silicon Valley, California. This facility provides co-location service, which is an unmanaged service that provides rack space and network connectivity via a high-capacity backbone. The building houses 62,870 sf of data center space, 7,310 sf of office space, 25,170 sf of support space and 5,390 sf of electrical room space. Roughly 60 percent of the building is data center space. Combined office and support space accounts for 32 percent of the building. 75 percent of the data center was occupied during the monitoring period. The data center's environmental system operates 24 hours a day year-round. The users of the co-location space require full access to and control of their caged space 24 hours a day.

Customer Cage

Electrical Equipment and Backup Power System

Electricity use at Data Center Facility 1 was monitored from December 19, 2000 through December 26, 2000. Facility 1 has a PG&E service feed of 4,000 kVA. Of this, an average of 3,540 kVA is being used. The site drew an average of 2,990 kW over the period of December 23, 2000 through December 26, 2000. The load varied ± 3% from the average, and the load factor was 0.96.

Chart 1. Whole Building Power Consumption



The facility utilizes Liebert uninterruptible power supplies (UPS) to condition the utility power in order to shield critical loads on the data center floor from disturbances. In addition, a constant delivery voltage to the data center is maintained. Anytime the voltage drops below 480, the UPS systems' batteries feed in the necessary voltage to maintain 480 volts. The UPS converts AC current and stores it as DC current. When the voltage is needed, it is converted back to AC current. In the event of a power loss, 4 Cummins diesel generators each provide 2,000 kW each for backup. At fifty percent load (4,000 kW), the generators with a full tank of diesel fuel can provide electricity to the building for approximately 40 hours. The data center is designed for N+1 redundancy on the electricity circuit level.

UPS Module

Cooling System

The mechanical pad includes four Evapco 340 ton, closed circuit water-cooling towers and condenser water pumps. This cooling tower plant provides condensed water to the computer room air conditioning (CRAC) units, and to office space air conditioning units and heat pumps located throughout the building. Each cooling tower has two two-speed fans and a circulating water pump. The condensed water loop consists of four pumps, with three pumps operating at a time. The cooling tower plant is designed for a redundancy of 15 percent.

The data center is on a raised floor, through which cooling air is circulated via the CRAC units. Forty-eight CRAC units, with a cooling capacity of twenty-two tons each, serve the space. The room temperature and relative humidity are maintained at an average of 64 °F and 42 %, respectively. Because it was built out in phases, the data center is divided into three different areas.

Data Center CRAC Unit

Facility 1 has four electrical rooms, each equipped with four CRAC units with a cooling capacity of ten tons apiece. A temperature of 68 °F and relative humidity of 45% are maintained in the electrical rooms. Both types of cooling units have a compressor EER (energy efficiency rating) of 11.7.

II. Electricity Use Characteristics

Facility A's end-use of electricity is shown below in Table 1 and Chart 2. "Other" was calculated by subtracting all of the measured data from the "Whole Building" power. Over 75 percent of the power goes to energizing the data center: 51 percent for server and related equipment loads, and 25 percent to the cooling equipment. Furthermore, 34 percent of the power goes to the HVAC equipment. This is a significant amount of the whole building power consumption and is where energy efficiency opportunities can be taken. A 15 to 50 percent reduction in HVAC electricity use can be achieved. This corresponds to 152 to 506 kW of electricity savings. "Other" contributes 13 percent of the whole building consumption; it includes items such as losses of power in the electrical equipment, office plug loads, and domestic water heating.

The power energizing the data center floor remains relatively constant throughout the day. This can be verified by examining the Chart 4 which shows the power drawn by the CRAC units and server loads in a section of the data center over a period of three days. The server load power varied ± 0.5% from the average. This indicates that power drawn remains the same regardless of the peak time usage of the servers and supporting equipment. The CRAC unit power varied ± 9% from the average, demonstrating that the internal heat load is fairly constant and that the building shell load has little effect on the environment.

Table 1. End-Use of Electricity

Description	Electricity Consumption (kW)	% of Whole Building	Square Feet (sf)	Watts / sf
Whole Building	2,990	--	102,500	29
Data Center Server Load	1,500	51	62,870	24
Data Center CRAC Units	738	25		12
Cooling Tower Plant[1]	114	4		1.8
Electrical Room Cooling	118	4	5,390	22
Office Space Conditioning	41	1	7,310	5.6
Lighting	73	2	102,500	0.7
Other	402	13	102,500	3.9

[1] Assume that all cooling tower plant power is used for data center cooling. This is a simplifying assumption.

Chart 2. Facility 1 Electricity End-Use

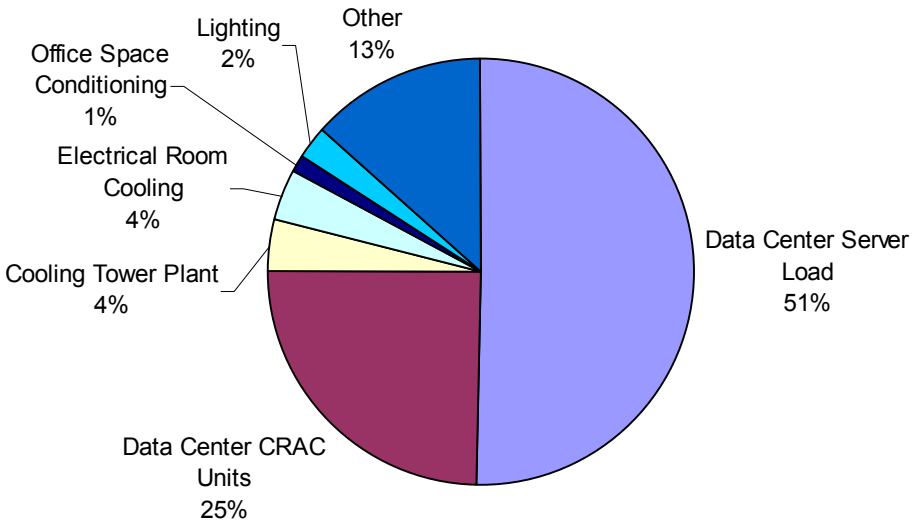


Chart 3. Facility 1 Operating Energy Densities

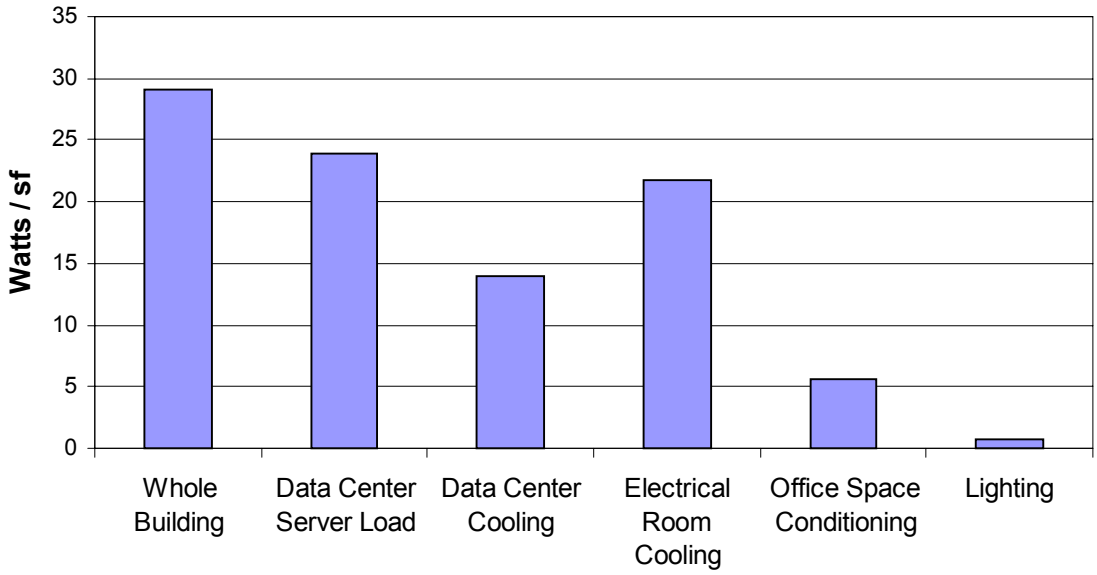
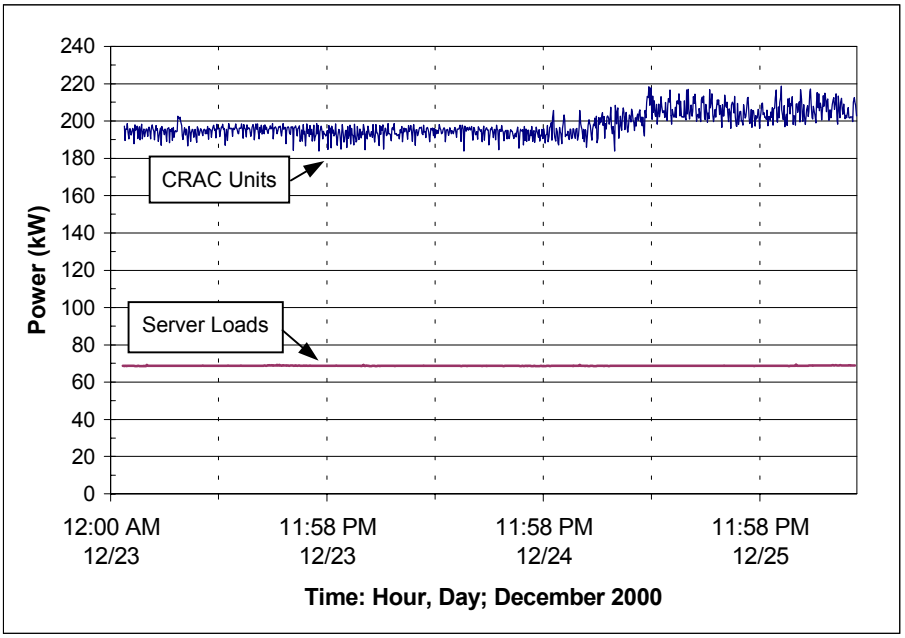


Chart 4. Constant Power Drawn by Data Center CRAC Units and Server Loads



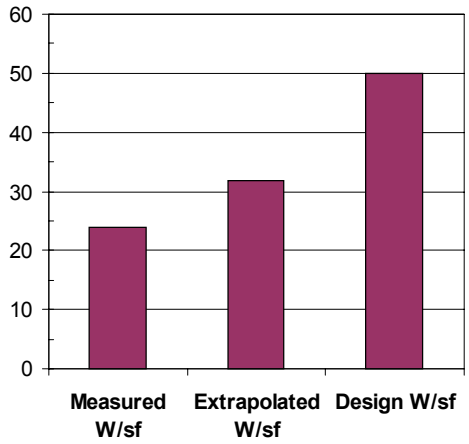
III. Electricity Use Diversity

In determining the size of the equipment needed in a data center facility, designers, in most cases, use an energy density value expressed in watts per square foot (W/sf). The type and number of server equipment in the data center are difficult to estimate; designers therefore oversize electrical equipment, so that a lack of capacity will not be a concern. Table 2 shows the operating conditions of the facility in comparison with the designed conditions. An extrapolated value was also calculated to determine what the operating W/sf would be if the data center were fully loaded.

Table 2. Server Load Diversity Factor

Measured W/sf	24
Extrapolated Full Load W/sf	32
Design W/sf	50
Diversity Factor (Measured / Design)	0.48
Diversity Factor (Extrapolated / Design)	0.64

Chart 5. Server Load Density



The data center was only 75 percent occupied at the time of monitoring. Thus 75 percent of the 62,870 sf area was used in calculating the extrapolated data center server load. The extrapolated diversity factor demonstrates that when the data center is fully occupied, it will operate at 64 percent of the expected or designed load.